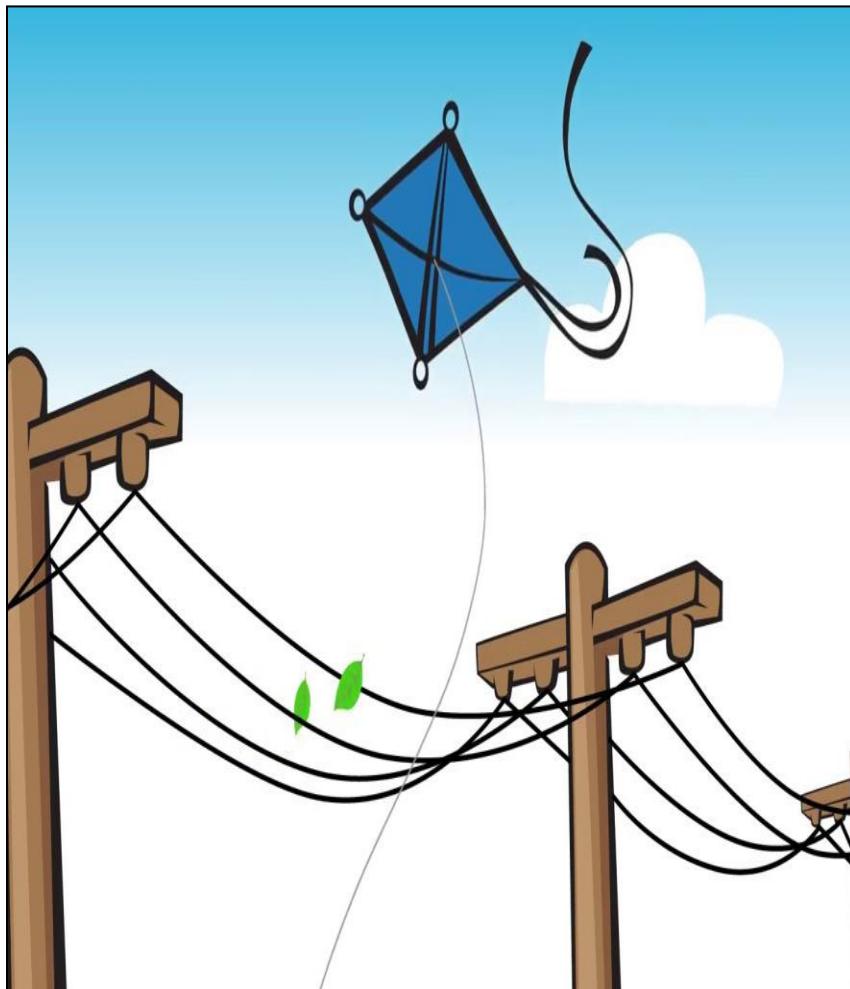


PPT on Electricity safety



Based on a Paper
**“Electricity safety:
Tragically falling
through
the governance gaps”**
by
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Introduction

- Massive “Rural Electrification” initiatives supported by GOI from 2005 have resulted in bringing Electricity to every house.
 - One of the unfortunate & neglected side effects of this program is rising electricity accidents.
- Electricity systems at the point of USE, can cause electric shocks (electrocution) & fires due to electrical faults (Short circuit). These in turn lead to human or animal injuries (non-fatal) or deaths (fatal) & also damages to appliance or property
- Lightning also causes Electrical accidents thro' Direct strike or HV surges in electrical network: Since lightning is a natural phenomenon requiring separate protection measures, it is not covered in this paper
- Main Objective of PRAYAS paper is to highlight the seriousness of electricity accidents & suggest steps to reduce them

- Accidents, as the saying goes, do not just happen, but are caused. Power utilities, Regulators, Consumers, Sector Professionals & General public have roles in causing accident

Info on electrical accidents is provided by:

- Annual Accidental Deaths & Suicides in India (ADSI) Report prepared by National Crime Records Bureau (NCRB)
- Annual General Review of CEA: based on Reports of Chief Electrical Inspector GOI (CEIG), State Chief Electrical Inspector (CEI)
- CAG Reports/Electricity Safety Manuals of some States.
 - Data about human deaths due to electrical accidents is collected by State Police Depts. Reports from 1967 are available at the website of National Crime Records Bureau (NCRB) as the Accidental Deaths & Suicides in India (ADSI)

- As per NCRB's ADSI report, 15,258 people died in CY 2020 due to Electrical shocks & fires. (CY: Calendar Year Jan-Dec)
- CEA reports 7,717 fatal human accidents in FY 2020. (FY: Financial Year Apr-Mar)
 - Nos are vastly different perhaps due to inefficiencies data collection & reporting issues. ADSI reports No. of People died in accidents & CEA report indicates No of Accident
 - In one accident there can be more than one fatalities
- But the worrying Fact is that No. of accidents have been steadily increasing over the years.
- Fatalities per 1 Lakh population (also called as fatality rate) is the most used parameter to compare across different accident causes or geographies.
 - In India, fatality rate has been increasing over the years & is little above 1, as per ADSI data for CY 2020

- Most of the electrical accidents in India happen in Dist system or at non-IND (R/C/AG) consumer locations.
 - State-wise analysis of accidents indicates that 85% accidents occur in 11 States: AP, C'garh, GUJ, Kerala, KAR, MP, Maha, RAJ, TN, TEL & UP.
 - This is to be expected since the population, energy handled, consumer mix & nature of Dist infrastructure vary across states.
- There is a need to strengthen efforts to reduce accidents in these states.
 - Within the states, there is variation in the No. of accidents based on consumer mix, state of maintenance of Dist network, climatic conditions & Safety awareness.

Major cause of accidents is: contact with live conductors due to:

- Low priority to safety,
 - Bad design/ Poor maintenance,
 - Un-authorised connection/ Un-autorised Repair,
 - Bad quality earthing, & inadequate protection systems.
- CEA notifies safety Regulations, which all utilities are expected to follow. Electrical Inspector at National & State levels have a mandate to implement these regulations.
- SERC have a broad mandate over the functioning of Power sector, but do not explicitly have a role in safety.
- Since most accidents occur in Dist system, DISCOMs have the highest role to play in reducing accidents.
- But for Discoms,
 - improving financial health, reducing energy losses & providing reliable power to consumers are higher priority functions.

- Accidents involving humans (which lead to injuries or deaths of humans) are likely to be better reported, & analyzed in this study
- Analysis of Deaths due to lightning & fire caused by electrical faults, affecting animals are not covered in this Study

In ADSI Reports, accident data is available from:

- 1967 for accidents due to Lightning
- 1984 for accidents due to Electrocution (shock),
- 1995 for Fires due to electrical short circuit (electrical fires)

Aim of the Study: to highlight seriousness of Electricity Accidents & suggest steps to reduce them, without fixing the blame on any specific stakeholder

- Accidents, as the saying goes, do not just happen, but are caused.

Analysis of National overview of Electrical Accidents

Analysis of Accidents' data indicates that Human deaths due to Electrical Accidents were due to following reasons:

- Electric shock (Electrocution): 73% ,
- Electrical fires: 11% &
- Lightning: 16%.
- No. of deaths due to lightning (a natural cause) has been relatively constant over the years, but deaths due to other two causes have been increasing.
- ADSI gives correct number of electrical accidents & deaths. One possible reason could be that fatal accidents are more likely to be reported by Police & hence compiled into ADSI reports
 - ADSI data from 1991 to 2020, indicate that No.. of human deaths has increased more than five times from 2,933 (1991) to 15,258 (2020), (in 30 yaers) indicating a Compounded Annual Growth Rate (CAGR) of 5.9%.

- As regards incidence of human deaths (deaths/Lakh population), it has been increasing from 0.35 (1991) to 1.13 (2020), showing a **disturbing increasing trend**. Higher incidence could be due to spread of electrification and/or growing neglect of safety.
- CEA, in its annual **“AI Electricity Statistics”** provides data about electrical accidents affecting humans & animals:
 - Human fatal accidents have increased from 3,239 (2009) to 7,717 (2020), indicating an increase of 2.5 times in 11 years (CAGR: 8.2%)
 - No. of non-fatal human accidents have not increased as much. (probably because they are not being properly reported)
 - No. of Total accidents (human or animal, fatal or non-fatal) have been increasing from 8,751 (2009) to 20,951 (2020), an increase of 2.4 times (CAGR: 8.4%).
 - Fatal accident rate (number of fatal human accidents/Lakh population), has significantly increased from 0.28 to 0.58 during 2009-2020
 - No. of animal fatal accidents increased from 3,248 (2009) to 9,219 (2020), an increase of nearly 3 times.

- **95-99% of animal accidents are fatal, perhaps because only serious accidents are reported by the cattle owners.**
- It may be noted that ADSI reports No of human deaths, whereas CEA reports fatal human accidents (**more than one person may have died in one fatal accident**)
 - CEA reports are based on inputs from DISCOMs & State CEIGs, & may not include accidents due to electrical fires.
- Data of fatal human accidents from the **USA, EU, Australia-New Zealand or Japan shows** that the fatal accidents are steadily reducing over the years & Fatality rate (deaths/1 Lakh population) around 0.03 to 0.04 (0.01 in Japan), very very small than Indian figure. (about 1.0/Lakh Population)
 - Data from countries like **Brazil or South Africa** show similar trends of increasing number of fatal accidents & comparable fatality rates.

Appliance & property damages are neither reported by ADSI nor by CEA

- Table on next slide gives data on human accidents reported by CEA for 2020 (FY2019-20), accidents/lakh of mid-year population, proportion of mid-year population & proportion of energy handled.
- It can be seen that accidents/lakh population vary widely across states. (mid year AI population: 132 CR & FY 2019-20 TTL Energy handled: 1383 BU by AI Grid)
 - AP, C'garh, Guj, Kerala, KAR, MP, Maha, Raj, TN, TEL & UP together account for around 85% of total accidents & 75% of total energy handled by the Grid.
- This Study does not analyse accidents related to animals, even though most of the accidents affect animals, such as cows, buffaloes & goats, which are crucial for rural livelihood.

Human Accidents in FY 2019-20 (CEA Data)

State	No of Human Accidents	Accidents/Lakh Popoulation	% of TTL Population	%of TTL Energy
MAHA	1518	1.2	9.5	10.5
KAR	1648	2.6	4.9	5.1
RAJ	1133	1.5	5.1	5.8
MP	1106	1.4	6.2	9.4
TN	905	1.3	5.3	7.5
GUJ	785	1.2	4.9	9.0
TEL	756	2.0	2.9	4.2
UP	550	0.2	17.4	93
AP	449	0.9	4.0	5.6
TTL AI	11,541	0.9		

No. of accidents depend on following parameters:

- Population/ Number of consumers
 - Number of AG pump sets,
 - Energy handled by the grid,
 - Quality of electrical network/ maintenance &
 - Safety awareness.
- It is not easy to establish correlation with all these parameters, but a study of data trends across past few years would give some pointers.
 - From 2015 to 2020, on an AV, every year in India, there were 10,841 human fatal accidents, growing at a CAGR of 4.5%.
 - Average fatal accidents/lakh population: 0.8,
 - Accidents/lakh consumers: 4,
 - Accident/lakh A pumpsets: 51.3
 - Accident/BU handled is 8.6.

- Eleven states account for 87% of human accidents in the 6 years, (2015-2020): AP, C'garh, GUJ, Kerala, KAR, MP, Maha, Raj, TN, TEL & UP
 - KAR & MAHA have the highest share of accidents.
- Number of accidents have been increasing in this period at a CAGR of 4.5%,

Who, where & why of accidents?

- 'Who' suffers the most due to electrical accidents: *Utility Staff, contract workers, Consumers & general public.*
- 'Where' i.e. the geographical location of accidents. These could be villages, towns, cities, some districts or regions.
 - Location can also be electrical, based on electrical parameters like voltage level or functional aspect in the electrical system.

Who are affected by accidents?

- CEA or ADSI reports do not have info about this,
 - Majority of accidents occur in Dist systems or at consumer locations.

Next slide gives a breakup of those, affected by fatal accidents:

- Data is not for the same year, but given as per data availability for different DISCOMs.
- From the last column, it can be seen that in more than 90% of cases, general public is affected.
- As per the data for five KAR DISCOMs for FYs 2019-2021, human fatalities of public were 95% of total, whereas only 49% of the non-fatal accidents affected public. (Probably not being reported)
 - In case of non-fatal accidents, DISCOMs & Contract staff are affected as much as the public.(about 50% each)
- Non-fatal accidents can cause life-long disabilities & some may result in death at a later time,

Fatal Accidents: Who is AFFECTED?

Discoms name & year	Discoms/ Contract Staff	Public	Total	Public %
APEDCL 2017	2	197	199	99%
KAR 2019	18	405	423	96%
Kerala SEB 2019	12	237	249	95%
MSEDCL 2017	32	799	831	96%
TSSPDCL 2017	29	320	349	92%

Where do accidents happen? Geographical Spread:

- ADSI annual reports until 2013 provide break-up of accidents in megacities (cities with population > 1 million).
- In 2013, electrocution deaths in 55 megacities were 11% of total deaths, which correlates with the proportion of population in megacities.
- AI human fatalities (due to electrocution & electrical fires) per lakh population based on ADSI for 2012 is 0.84 & this parameter is lower in cities like Ahmedabad, Bengaluru, HYD or Mumbai.
 - Delhi with 2% of AI population & 2% of electricity consumers, accounted for 0.4% of total AI accidents in 2020.
 - In TEL State, in 2017, highly urbanised HYD Dist, with 26% of State population, had only 7% of total accidents.

- It is observed that a high number of accidents occur in Dists which have “**high density of AG pump sets, are arid or have high incidence of poverty**”
 - e.g. In Mahbubnagar & Nalgonda circles (TEL), Anantapur & Kurnool circles (AP) and Akola, Yavatmal, Nagpur (Rural), A'bad (Rural) & Ahmednagar circles (of Maha), higher number of Electrical Accidents are reported
- But a proper assessment is possible, only if division wise & urban-rural segregated accident data is available.
- ADSI reports deaths due to fire caused by electrical short circuits also.
 - In 2013, out of total 1,690 deaths due to this, 25% occurred in megacities. This indicates that Electrical fire accidents are more common in cities, whereas
 - “Shock accident deaths”, are more prevalent in rural areas (10,218 in 2013)

Electrical spread:

- As per CEA Annual statistics report, in 2020 (FY20), out of total 11,541 human accidents:
 - 89% occurred at supplier location, (Dist)
 - 1% at IND consumer location &
 - 10% at non-IND consumer locations.
- As per a CEA safety training presentation, 1% accidents occur in Gen, 29% in Trans & 70% in Dist
 - Gujarat CEIG report, indicates that out of 585 human fatal accidents in 2019, only 2 occurred in Gen, 36 (6%) in Trans & balance 547 in Dist System.
 - 201 (34%) in Discom System Network, 73 (13%) at IND consumer locations, 46 (8%) at non-IND (Co or Govt) consumer locations & 227 (39%) at small consumer (non-IND, Comm, AG or Dom) locations.

- Max accidents occur due to contact with Live Conductor / snapping of conductors, both of which occur on 11 kV (lines, poles & DTs) or LT systems (lines, poles & service wires). Consumer locations (like AG pump sets & houses) are another major site for accidents.

Key points to summarise:

- Geographically most of the accidents appear to be taking place in Rural areas, but considering the rapid urbanisation, poor Urban localities (slums) also need attention. Most accidents occur in Dist system network & non-IND consumer locations.
- LT consumer locations are the major electrical sites for accidents, & hence need higher attention

Root causes of Accidents:

- From ADSI reports, it is observed that 88% deaths are due to electric shock in Electrical accidents. (major cause of accidents.)

Major causes of Electrical accidents:.

- (1) Accidental contact with LIVE conductor due to:
 - lack of boundary fencing for DTCs, low hanging conductor (aling of conductors hahvin multiple joints), poor maintenace of HT/LT system by Discoms open switch boards, carrying long metal objects near conductors, exposed conductor on poor quality service wire or
 - Temporary connections & un-authorised repair (Carrying out maintenance without switching off supply & without using protective gloves)

- (2) Failure to isolate faults: Circuit Breaker at S/s, or fuse at DT often do not isolate live sections when there is snapping or accidental contact
- (3) Fire & explosions, especially at oil cooled DTs, due to poor maintenance or leakages.
- (4) Poor Earthing at consumer locations &/or absence of residual current protection. Poor Earthing at DT results in HV in the neutral wire, leading to accidents & damage to appliances
- (5) In case of HVDS systems, it is extremely important to construct & maintain very low earth resistance at DT locations: When this is not done, HV (6.6 kV) can develop at electrical wiring of consumer, leading to shock accidents)

- (6) Electrical fires, caused due to sparks or overheating, (faulty wiring, poor maintenance, or failure of protection systems)
- (7) Poor construction & bad maintenance of Electric Fencing, constructed to protect crops from wild animals. Lack of awareness leads to accidental deaths.
- (8) In case of “Home Invertors” or “Grid connected Solar RT systems”, there is a possibility of inadvertent back-feed into the Dist Network from consumer locations which results in power flowing back into Dist network from consumer locations, during power outage : **DISCOM staff engaged in mainatenance can get electric shocks during such occasions.**

Challenges in Safety Governance framework

- CEA prepares & updates regulations on electricity safety, which are expected to be followed by all power utilities.
- CEIGs have the responsibility to inspect & certify the safety of electrical installations. State CEIGs come under State Energy Dept. & their main focus is on Electricity Duty collection & audit of HT consumers.
- Based on the CEA (Measures relating to safety & Electric Supply) Amendment 2015 & Amendment 2018), States have to notify voltage levels below which self-certification is possible
 - A brief study of few states show that notified self-certification voltage varies from 66 kV (Punjab), to 33 kV (Haryana, MP, Rajasthan) to 11 kV (AP, Maha) to 650 V or below (KAR, Kerala, Odisha), because of shortage of staff, at State CEIG.

- The concept of “Chartered Electrical Safety Engineer” (CESE) was introduced as an amendment to CEA Safety Regulations in 2015 & guidelines issued in 2018. CESE has good potential, especially since the staff at State CEIG is limited
- Based on notified certification process, Chartered Engineers could undertake Safety inspection & certification.
 - Unfortunately, progress of this scheme not Satisfactory. CEIG's role in implementing safety Regulations especially at LT voltage level is almost zero
- GOI has many initiatives to promote electricity connections, RE, EE, financial health of Power sector & Power markets. But unfortunately, electricity safety targets or specific measures to improve safety are not part of Dist Reform programs or National Electricity Policy.
- EA2003 does not give SERCs a specific mandate on Safety. But SERCs have a broad role in Regulating the Power sector, & hence could prepare & enforce safety through SOP Regulations or directives to DISCOMs.
 - CEA with the help from SERCs could play a Proactive role in implementing Safety Regulations. FOR needs to take this issue on priority.

- For many consumers, continuity of supply with minimum investment (of time & money) is the priority. Because of lack of awareness, they are victims of electricity accidents.
- Many Rural & Farmer organisations have been focussing on “Compensation for Accident victims”. This is no doubt important, but no amount of monetary compensation is enough for loss of life of the bread earner.
 - These organizations can play a vital role in reducing accidents.
- DISCOMs being the first interface to consumers, have a key role in safety, since they are responsible for network expansion, O&M and revenue collection.
- DISCOM staff (including contract staff) & public are the most affected by accidents. But there is absence of periodic Safety Audits, planned actions to reduce accidents. Elevating electricity safety needs to be one of the Key Performance Index

Best practices followed in various States

- Maha, GUJ, KAR, Kerala, HAR, Odisha, Assam & Tata Power prepared detailed safety manuals
 - Mobile application of MSEDC has features which allow public to report potential accident situations like leaning poles, low hanging conductors, sparking joints etc.
- MPERC & GERC included Safety in the SOP regulations for DISCOMs. GERC has given orders on safety & compensation, based on petitions by consumer organisations
- RAJ SERC gave a land mark order in 2019, directing DISCOMs to carry out independent safety audits & conducting safety training programs
- APERC, in its tariff order for FY22, directed DISCOMs to designate Safety officers, submit monthly safety audit reports & organise training programs for their staff & electricians.
- KSEB has institutional structure for safety, headed by a Director level person: KSEB Officers' Association have conducted studies on accidents & organised many training programs on Safety awareness

Short Term Action plan: for upto 3 years

1. Improve Data quality:

- To improve data collection & reporting by CEA & DISCOMs. CEA should publish all data collected & indicate actual number of human/ animals affected.
- Better “Safety Data” Coordination across: CEIG, DISCOMs, Fire Dept & Police Dept..
- Forum of Regulators (FOR) could suggest better formats & SERCs could ensure that DISCOMs routinely file this info. Basis for categorisation of Accidents & the details of accident investigation report(s) should be available in the public domain.
- CEA/SERCs could commission “Independent Safety Surveys or Audits” with focus on high accident areas to get a better idea of ground reality.

2. Safety initiatives as part of National programs:

- MOP need to prepare plan for Accident reduction initiatives with clear targets & Road map for reducing accidents.
 - Safety should form an integral part of initiatives for system improvement (RDSS) so that sustainable, affordable, quality & safe electricity access is ensured for all.

3. Developing a Safety Metric:

- Top management of DISCOMs, CEIGs & SERCs need to give high priority to the neglected safety dimension. Discoms need to provide sufficient field staff for Dist O&M. & ensure regular training & safety awareness programs of all field staff, electrical contractors, consumers & general public.
- SERCs should include safety as part of SOP Regulations & ensure regular monitoring. Sanctions for CAPEX and O&M expenses should be also linked to the safety metric. Mechanism to fix “accountability of accidents”, needs to be introduced

4. Strengthen “Safety Institutional structure” in States:

- State CEIGs, DISCOMs & SERCs need to work together on accident reduction initiatives. Dedicated safety officers should be identified at State, Circle, Division & S/Dn levels of DISCOMs, who are accountable for monitoring & improving safety.
- Services of Chartered Electrical Safety Engineers may be taken for periodic inspection of Dist N/w.
 - Institution of Engineers” & Engineering colleges could be involved for Certification & training, similar to industrial safety or other technical issues
 - Rural & farmer organisations need to focus on accident reduction rather than limiting to timely payment after an accident

Medium term action Plan (to be completed within 3-5 years)

1. For Effective implementation of Safety Regulations:

- CEA needs to give more attention to ensure that its safety Regulations are implemented by DISCOMs, & enforced by CEIGs. CEA could allow professionals & non-Govt agencies to participate in Safety processes. This should not be a one-way process of providing comments, but result in a two-way interaction,
- National Standing Committee on Electrical Safety (SCES, formed in 2017), has been constituted with Central & State Govt officials as Members
 - Representatives of public & private sector Cos & safety professionals should also be included in SCES so that their expertise could also be used for effective implementation of safety Regulations
- Since States have more significant role in accident reduction, formation of similar State Level Electricity Safety Committees may be taken up. This would help in ensuring periodic inspection & testing, fixing accountability for accidents

2. Facility for Public reporting of accident-prone situations:

- Many DISCOMs have mobile apps which could be improved so that public in DISCOM areas can report accident prone situations like lines touching trees, sparking joints or leaning poles.
 - Toll free numbers for complaints should accept such complaints.

3. Exploring Technical Innovations:

- Good earthing practices & robust fault tripping systems at 11 kV & LT systems are crucial.
- Bare conductors should not be left sagging beyond permissible levels & poles should not be leaning. Deployment of insulated Aerial Bunched Cables (ABC) could be explored for long LT lines, which would reduce accidents & power theft.
- Pole guards at 11 kV poles, used in TN & KAR ensure that CB at the S/s trips, when there is a ground fault on 11 kV line.
- Residual current CB at households reduce shock accidents. They need to be popularised

- DTs should be installed on high pedestals & should have good fencing.
- Motor starters at AG pump set locations should have non-metal enclosures & standard protection devices. If the enclosure is of metal, it should be properly earthed.

Some of these measures should be part of the newly launched Revamped Dist System Scheme (RDSS) initiative by Ministry of Power (MOP)

4. Increasing accountability for safety

- Normally, DISCOMs accept responsibility only for a small proportion of accidents.
- This has to be checked thro' credible third-party audits. In cases where Discoms are responsible, there is no clear mechanism to fix accountability & prevent recurrence.
- A reward– disincentive mechanism should be prepared to motivate field staff to proactively work to prevent accidents.
- SERCs have a much better system to increase accountability of service providers & it is better to bring CEIG oversight to SERC's ambit, especially for Dist at 11 kV & below. This would require amendments to the Electricity Act for coordinated working of CEIGs & SERCs.

Finally...

- Electricity safety is a public interest challenge. Safety has a low priority in Discom's performance metric.

Accident reduction requires:

- Improving Technical & management measures
- Specific safety initiatives by GOI, State Govts (Regulations)
- Increased priority to safety by Discoms,
- Strengthening the role of State Electrical Inspectorates, (CEI)
- Proactive efforts by SERCs to ensure implementation of safety measures &
- Building safety awareness in public.

There is a need for:

- better data collection, strengthening safety institutions, developing safety metric for DISCOMs, involving public & professionals in safety initiatives & utilising technological innovations.
- Steps to reduce accidents needw strengthening. All Stakeholders need to take part in improving safety.

Electricity supply: Reliable/ Affordable/ Good Quality/ Safe.

Thanks !!! Let SAFETY be our prime moto

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**"If you cannot do
Great things;**

**Do Small things
in a Great way"**